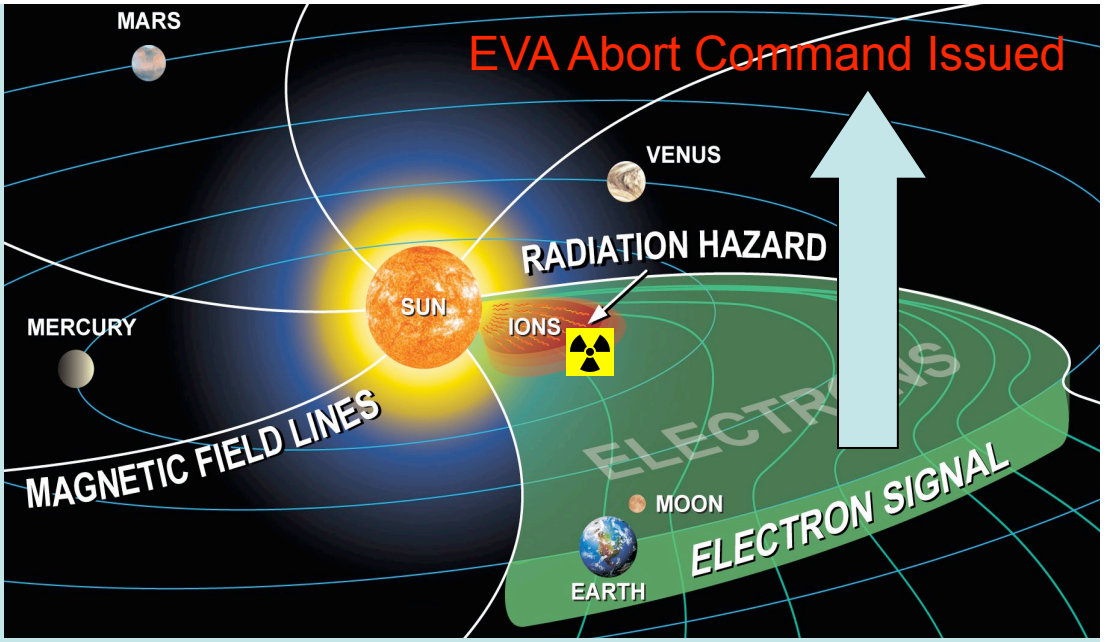
Space Weather Forecasting Tool:

Basics 1/2

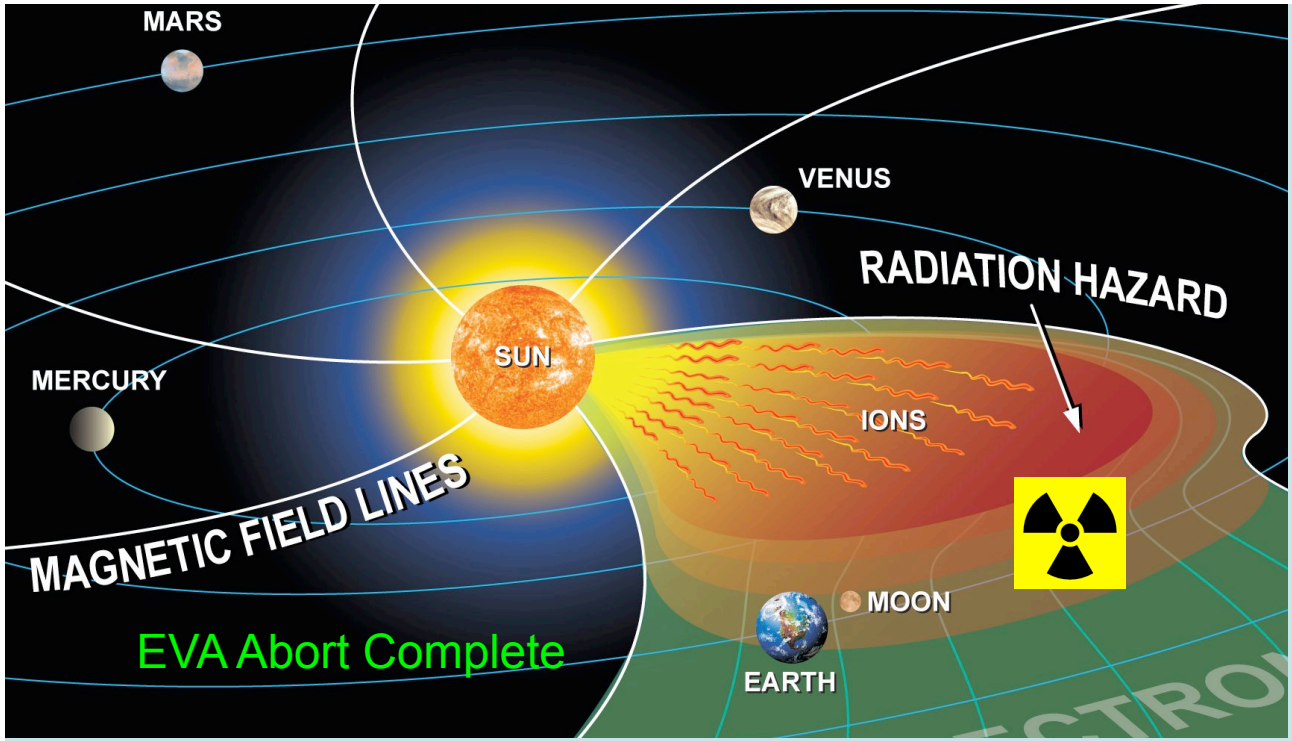
Astronauts venturing beyond the protective magnetic field of Earth face the direct effects of the Sun and unpredictable outbreaks of activity.



Solar electrons reach the Earth-moon system about one hour before the solar proton radiation hazard arrives.

Within even one hour, explorers can be engulfed with particles that cause harmful long- or short-term health effects and put missions at risk. Although the inside of a spacecraft or lunar base can be made relatively safe, “Staying Inside” hampers productivity. “Going Outside” requires a space weather warning system.

New research has shown that electrons traveling at the speed of light are always present in solar particle eruptions. These electrons – traveling much faster than the hazardous solar energetic protons – follow the magnetic lines of force from the Sun to the Earth. Therefore, they can be used as an reliable early warning sign of hazardous radiation ahead.

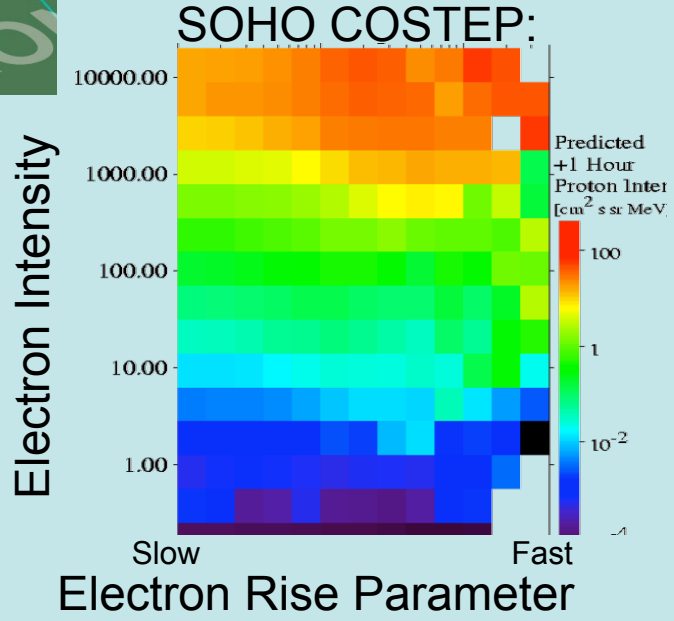


Basics 2/2

Even in the case of the fastest-rising major proton event on record (Jan. 20, 2005), the electron precursor signal was detected 20-25 minutes in advance.

A one-hour warning has the potential to provide the advanced notice needed for efficient EVA planning.

An important example of the potential for further rapid transition of SMD Research to SOMD/ ESMD Operations – May 2007 to Feb 2008 – this new prediction tool has now entered the Verification and Validation phase by the JSC/ SRAG preparing for future use in Shuttle, ISS, and CEV operations.



Empirical Forecasting Matrix Translates Solar Electron Data into +1h Proton Hazard Forecast (Posner, *Space Weather*, 2007)

How to Use/Interpret the Displayed Data

- **This CCMC distribution of the SOHO/COSTEP forecasting tool provides two output graphs displaying proton intensities. These are updated approximately every minute.**
- **The top graph shows the actual measurements of protons. Symbol keys are given here as well. The scatter in the displayed data results from statistical uncertainties and appears particularly large when the proton flux is very low.**
- **The bottom graph shows the 1-hour forecast intensity for protons at 1 AU. Symbol keys for forecast proton energies are provided on top.**
  Only at times that data is displayed at the very right hand side of the graphs, the observations and forecasts are live ("LIVE DATA UPDATE" or "LIVE FORECAST" appear in the respective plots). Live forecast requires SOHO to be in contact with DSN. Out-of-DSN-contact periods are the main cause for this tool not being live all the time.
- **Hazardous proton exposure for explorers on the moon or in transit beyond the Earth's protective magnetosphere is imminent at times when the forecast flux of beyond 15 MeV protons reaches the yellow or even red intensity range.**
- **Interpretation: The forecast intensity refers to solar particle events with particle release very close to the Sun. Only for this type of event, a forecast utilizing the speed advantage of electrons over protons is possible. Other events occur in which particles are accelerated in the interplanetary medium, but these lack a reliable advance electron signal. For these events, nowcasting, i.e. looking at the real-time measured flux, is most important.**

A combination of the forecast proton intensity and the measured proton intensity have to be used in order to most reliably warn of transient radiation hazards with SOHO/COSTEP.

Radiation dose should always be derived from the actual measurement, and not from the forecast proton flux. The forecast flux should only be used as an advance warning in the onset phase of severe solar particle events.

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